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Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims

1. (Original) An adaptive, dynamic, integrated, and automated optimizer system for rapid generation of alternative pilot training plans in response to a user request, which comprises:

a data base system having stored therein system bid information, pilot data, training information, and user request information including optimization options selected by said user request;

an optimizer controller in electrical communication with said data base system for receiving and acknowledging said user request, and generating therefrom an optimizer session for storage in said data base;

an optimizer container in electrical communication with said optimizer controller and receiving said optimizer session for issuing data requests and training plan generation requests;

an optimizer data provider in electrical communication with said optimizer container and said data base system, and receiving said data requests for retrieving data from said data base system for use in the generation of said alternative pilot training plans; and

an optimizer engine in electrical communication with said optimizer container and said optimizer data provider for generating a mixed integer programming model of said optimizer session in response to said training plan generation requests and based upon data retrieved by said optimizer data provider from said data base system, for solving a linear program relaxation of said mixed integer programming model and thereafter solving said mixed integer programming model to provide a feasible optimized solution, and for deriving an optimized pilot training plan from said feasible optimized solution.

2. (Currently Amended) The adaptive, dynamic, integrated, and automated optimizer system of Claim 1, wherein said mixed integer programming model is comprised of an objective function with variables and constraints, and said objective function is:

$$Minimize\ \ PNH\sum_t \sum_h NHCost_{ht} y_{NHht} + PNA\sum_t \sum_{i \in NA} NACost_{it} y_{it} +$$
$$PF\sum_t \sum_{i \in F} FCost_{it} y_{it} + Ppay(\sum_{i \in \lambda_1} a_i R_i + \sum_{i \in 58Y} a_i R_{58i} + \sum_{i \in \lambda_2} a_i M_i) +$$
$$PS * PBH \sum_h \sum_t S_{ht} / Block_{ht} + PE * PBH * (1/3) \sum_h \sum_t E_{ht} / Block_{ht}$$

wherein PNH is Level of importance of New Hire Cost in the solution;

$NHCost_{ht}$ is Cost per new hire advanced to position h in period t (computed as the number of month between t and the end of the planning horizon, times the pay rate, times the average pay hours);

PNA is Level of importance of no-awards cost in the solution;

$NACost_{it}$ is Cost if pilot i NA is released in bid period t (computed as the number of months between t and the beginning of the planning horizon, times the pay rate, times the average pay hours);

$FCost_{it}$ is Cost if pilot i F is furloughed in bid period t (computed as the number of months between t and the beginning of the planning horizon, times the pay rate, times the average pay hours);

Ppay is Level of importance of pay protection cost in the solution;

PS is Level of importance of shortages in block hours in the solution;

PE is Level of importance of excess in block hours in the solution;

PF is Level of importance of furloughs cost in the solution;

PBH is Cost associated to each block hour missed due lack of crews; and

$Block_{ht}$ is Business plan block hours for position h in bid period t.

3. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein two of said constraints respectively cause all pilots who are straight advances to a same position to be advanced in seniority order, and all pilots who are straight displacements to be advanced in reverse seniority order as follows:

$$\sum_t t y_{it} - \sum_t t y_{i+1t} \le 0 \qquad \forall h, i \in SA(h), \text{ and}$$
$$\sum_t t y_{i+1t} - \sum_t t y_{it} \le 0 \qquad \forall h, i \in SD(h).$$

4. (Currently Amended) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein two of said constraints track shortages in block hours per position, and excesses in block hours per position as follows:

$$(\sum_{i\in H(h),k\le t} y_{ik} * uti_{hk} - \sum_{i\in H'(h),k\le t} y_{ik} * uti_{hk}) - S_{ht} \le Initial_{ht} - Blockhrs_{ht}(1-\alpha_{ht}) \quad \forall(h,t)\text{, and}$$

$$(\sum_{i\in H(h),k\le t} y_{ik} * uti_{hk} - \sum_{i\in H'(h),k\le t} y_{ik} * uti_{hk}) + E_{ht} \ge Initial_{ht} - Blockhrs_{ht}(1+\beta_{ht}) \quad \forall(h,t).$$

wherein Uti_{ht} is Number of crew hours utilization in position h in bid period t; and $Initial_{ht}$ is Initial number of hours for position h in the bid period t and is obtained by multiplying number of pilots in a given position in a bid period by respective utilization, and headcount includes retirements and absences.

5. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said constraints include three constraints to determine pay protection for pilots in a training set based on an order in which said pilots are trained and advanced, as follows:

$$R_i \ge (\sum_{t\in\phi(i)} ty_{it} - QA_i) \qquad \forall i \in \lambda,$$

$$QA_i \le QA_j \qquad \forall i \in \lambda, j -> next\_in\_P(i)\text{, and}$$

$$QA_i \le \sum_{k\in\phi(j)} ky_{jk} \qquad \forall i \in \lambda, j -> next\_in\_P(i).$$

6. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said constraints include three constraints to determine pay protection for displaced pilots in a training set based on an order in which said displaced pilots are trained and advanced, as follows:

$$R_i \ge (QA_i - \sum_{t\in\phi(i)} ty_{it}) \qquad \forall i \in \lambda,$$

$$QA_i \ge QA_j \qquad \forall i \in \lambda, j -> next\_in\_P(i)\text{, and}$$

$$QA_i \ge \sum_{k\in\phi(j)} ky_{jk} \qquad \forall i \in \lambda, j -> next\_in\_P(i).$$

7. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said constraints include two constraints to respectively determine pay protection for pilots in a training set that are already pay protected at a beginning of a planning horizon, and pay protection for pilots in a training set that are pay protected because they are advanced after an effective date, as follows:

$$R_i \geq \left(\sum_{t \in \phi(i)} ty_{it}\right) - G_i \qquad \forall i \in APP \text{, and}$$

$$R_i \geq \left(\sum_{t \in \phi(i)} ty_{it} - BidEff_i\right) \qquad \forall i \in \lambda .$$

8. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said constraints include a constraint to determine pay protection for pilots 58 years old that could have held a position but said position was not awarded, as follows:

$$R_{58i} \geq \left(N - \sum_{t \in \phi(i)} ty_{jt}\right) \qquad \forall j \in PP_{58}(i), i \in 58Y .$$

9. (Original) The automated optimizer system of Claim 2, wherein said constraints include four constraints to determine pay protection for pilots 58 years old that hold a position but could have held a better one, as follows:

$$RF_i \geq \left(N - R_{58i} - \sum_{t \in \phi(i)} ty_{it} + R_i\right) \qquad \forall i \in \lambda_2 .$$

$$M_i \geq \left(R_i - (N+1)A_{1i}\right) \qquad \forall i \in \lambda_2 .$$

$$M_i \geq \left(RF_i - (N+1)A_{2i}\right) \qquad \forall i \in \lambda_2 \text{, and}$$

$$A_{1i} + A_{2i} = 1 \qquad \forall i \in \lambda_2 .$$

10. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said user request includes number of new hires and a request to cluster new hires into groups, and said constraints include following three constraints:

$$\sum_{i \in NH} y_{NHi(t+L(i))} - KK_t = MM * K_t \qquad \forall t,$$

$$KK_t \leq \text{Residual} * P_t \qquad \forall t, \text{ and}$$

$$\sum_t P_t = 1$$

11. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said user request includes a requirement to cluster new hires into groups, and said optimizer engine determines an optimal number of new hires, and said constraints include following three constraints:

$$\sum_{i \in NH} y_{NHi(t+L(i))} - KK_t = MM * K_t \qquad \forall t,$$

$$KK_t \leq MM * P_t \qquad \forall t, \text{ and}$$

$$\sum_t P_t = 1$$

12. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said user request includes a requirement for said optimizer engine to determine balance of captains and first officers in groups for a training class, and Max $\{N_c, N_f\} = N_c$, then a first of following constraints is added to said constraints for each fleet and each bid period to track said groups, and a second of said following constraints is added thereafter to said constraints to enforce minimum percentage:

Σ captains going to training in bid period $t + C_t$
>= Σ first officers going to training in bid period $t + F_t$, and

$$\sum_t C_t \leq N_f (1 - \%balance).$$

13. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said user request includes a requirement for said optimizer engine to determine balance of captains and first officers in groups for a training class, and Max $\{N_c, N_f\} = N_f$, then a first of following constraints is added to said constraints for each fleet and each bid period to track said groups, and a second of said following constraints is added thereafter to said constraints to enforce minimum percentage:

Σ captains going to training in bid period $t + C_t$
$<= \Sigma$ first officers going to training in bid period $t + F_t$, and

$$\sum_t F_t \leq N_c (1 - \%balance).$$

14. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 1, which further includes an optimizer protocol layer in electrical communication with a user and said optimizer controller for accommodating interactive communications between said user and said optimizer controller.

15. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 1, wherein said optimizer engine determines costs associated with said LP relaxation, and uses said costs to modify cost factors of an objective function of said MIP Model to provide weightings of both block hour and dollar costs.

16. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 2, wherein said optimizer engine minimizes an objective function of said mixed integer programming model to have a lowest value within a region defined by said constraints.

17. (Original) The adaptive, dynamic, integrated, and automated optimizer system of Claim 1, wherein parameters of said mixed integer programming model are altered to provide multiple alternative solutions of said mixed integer programming model.

18. (Currently Amended) A method for rapidly generating alternative optimized plans for training airline pilots, which comprises the following steps:

receiving training problem information including system bid information, pilot data, and training information by way of a data input device, and a user request by way of a user interface, wherein said user request includes optimization options for generating said alternative optimized plans;

sorting said training problem information for each of said airline pilots for addition to a set of lists;

creating variables and constraints from said set of lists, and an MIP Model from said variables and said constraints, wherein MIP is a mix integer programming;

solving a linear programming relaxation of said MIP Model to generate a first solution with said variables having first values;

if said first solution is feasible, modifying block hour costs to have a value roughly twice as large as dollar costs;

solving said MIP Model to generate a second solution with said variables having second values; and

if said second solution is feasible, generating a training plan with associated costs from said second values.

19. (Original) The method of Claim 18, wherein said set of lists includes a retirement list, a no award list, a furlough list, a list of possible release months for pilots in said no award list and said furlough list, a list of 58 year old pilots, an advancement training list, a list of advancement months for pilots in said advancement training list, a list of classes to attend, a list of possible pay protecting pilots, an exception list, and a list of possible new hire advancement months;

20. (Original) The method of Claim 18, wherein the step of generating a training plan includes the following steps:

creating a second set of lists including a list of pilots to be trained, a list of advancement pilots, a list of no award pilots, a list of furlough pilots, a list of release pilots, and a list of new hire pilots from said second values;

determining pilot headcount in each position each day from times of occurrence of pilot training, pilot advancement, no award releases, furlough releases, and hiring of new hires;

calculating block hour capability by multiplying said pilot headcount by pilot utilization values provided by a user for each position and each bid period;

comparing said block hour capability with required block hours provided by said user for each position and each bid period to determine block hour shortages and block hour excesses;

creating class rosters for said pilots to be trained for each bid period;

compute dollar costs associated with said second solution; and

preparing training plan based upon said second set of lists, said pilot headcount, said block hour shortages, said block hour excesses, said class rosters, and said dollar costs.

21. (Canceled)

22. (Canceled)

23. (Original) The method of Claim 20, wherein said training plan includes values for all of said variables in said MIP Model, and at least one of said list of advancement pilots, said list of pilots to be trained, said list of no award pilots, said list of furlough pilots, said list of possible pay protecting pilots, and class rosters for all pilots to be trained.

24. (Original) The method of Claim 18, wherein said training plan includes at least one of pay protection costs, no award costs, furlough costs, and new hire costs associated with said second solution.

25. (Original) The method of Claim 20, wherein said dollar costs include at least one of new hire, pay protection, no award, and furlough costs.

26. (Original) The method of Claim 18,wherein said MIP Model is comprised of an objective function with said variables and said constraints.

27. (Original) The method of Claim 18, wherein said optimization options include level of importance of cost factors in said objective function.

28. (Currently Amended) The method of Claim 18, wherein said MIP Model is comprised of an objective function with variables and constraints, and said objective function is:

$$
\begin{aligned}
&Minimize\ \ PNH\sum_{t}\sum_{h} NHCost_{ht}\, y_{NHht} + PNA\sum_{t}\sum_{i\in NA} NACost_{it}\, y_{it} + \\
&PF\sum_{t}\sum_{i\in F} FCost_{it}\, y_{it} + Ppay\Big(\sum_{i\in\lambda_1} a_i R_i + \sum_{i\in 58Y} a_i R_{58i} + \sum_{i\in\lambda_2} a_i M_i\Big) + \\
&PS * PBH\sum_{h}\sum_{t} S_{ht} / Block_{ht} + PE * PBH * (1/3)\sum_{h}\sum_{t} E_{ht} / Block_{ht}
\end{aligned}
$$

wherein PNH is Level of importance of New Hire Cost in the solution;
$NHCost_{ht}$ is Cost per new hire advanced to position h in period t (computed as the number of month between t and the end of the planning horizon, times the pay rate, times the average pay hours);
PNA is Level of importance of no-awards cost in the solution;
$NACost_{it}$ is Cost if pilot i NA is released in bid period t (computed as the number of months between t and the beginning of the planning horizon, times the pay rate, times the average pay hours);
$FCost_{it}$ is Cost if pilot i F is furloughed in bid period t (computed as the number of months between t and the beginning of the planning horizon, times the pay rate, times the average pay hours);
Ppay is Level of importance of pay protection cost in the solution;
PS is Level of importance of shortages in block hours in the solution;
PE is Level of importance of excess in block hours in the solution;
PF is Level of importance of furloughs cost in the solution;
PBH is Cost associated to each block hour missed due lack of crews; and
$Block_{ht}$ is Business plan block hours for position h in bid period t.

29. (Original) The method of Claim 18, wherein two of said constraints respectively cause all of said airline pilots who are straight advances to a same position to be advanced in seniority order, and all of said airline pilots who are straight displacements to be advanced in reverse seniority order as follows:

$$
\begin{aligned}
&\sum_{t} t y_{it} - \sum_{t} t y_{i+1t} \le 0 \qquad && \forall h, i \in SA(h), \text{ and} \\
&\sum_{t} t y_{i+1t} - \sum_{t} t y_{it} \le 0 \qquad && \forall h, i \in SD(h).
\end{aligned}
$$

30. (Currently Amended) The method of Claim 18, wherein two of said constraints

track shortages in block hours per position, and excesses in block hours per position as follows:

$$\left(\sum_{i \in H(h), k \le t} y_{ik} * uti_{hk} - \sum_{i \in H'(h), k \le t} y_{ik} * uti_{hk} \right) - S_{ht} \le Initial_{ht} - Blockhrs_{ht}(1-\alpha_{ht}) \quad \forall (h,t), \text{ and}$$

$$\left(\sum_{i \in H(h), k \le t} y_{ik} * uti_{hk} - \sum_{i \in H'(h), k \le t} y_{jk} * uti_{hk} \right) + E_{ht} \ge Initial_{ht} - Blockhrs_{ht}(1+\beta_{ht}) \quad \forall (h,t).$$

<u>wherein Uti_{ht} is Number of crew hours utilization in position h in bid period t; and $Initial_{ht}$ is Initial number of hours for position h in the bid period t and is obtained by multiplying number of pilots in a given position in a bid period by respective utilization, and headcount includes retirements and absences.</u>

31. (Original) The method of Claim 18, wherein said constraints include three constraints to determine pay protection for said airline pilots in a training set based on an order in which said airline pilots are trained and advanced, as follows:

$$R_i \ge \left(\sum_{t \in \phi(i)} t y_{it} - QA_i \right) \qquad \forall i \in \lambda,$$

$$QA_i \le QA_j \qquad \forall i \in \lambda, j -> next\_in\_P(i), \text{ and}$$

$$QA_i \le \sum_{k \in \phi(j)} k y_{jk} \qquad \forall i \in \lambda, j -> next\_in\_P(i).$$

32. (Original) The method of Claim 18, wherein said constraints include three constraints to determine pay protection for displaced pilots in a training set based on an order in which said displaced pilots are trained and advanced, as follows:

$$R_i \ge \left(QA_i - \sum_{t \in \phi(i)} t y_{it} \right) \qquad \forall i \in \lambda,$$

$$QA_i \ge QA_j \qquad \forall i \in \lambda, j -> next\_in\_P(i), \text{ and}$$

$$QA_i \ge \sum_{k \in \phi(j)} k y_{jk} \qquad \forall i \in \lambda, j -> next\_in\_P(i).$$

33. (Original) The method of Claim 18, wherein said constraints include two constraints to respectively determine pay protection for said airline pilots in a training set that are already pay protected at a beginning of a planning horizon, and pay protection for said airline pilots in a training set that are pay protected because they are advanced after an effective date, as follows:

$$R_i \geq (\sum_{t \in \phi(i)} ty_{it}) - G_i \qquad \forall i \in APP \text{, and}$$

$$R_i \geq (\sum_{t \in \phi(i)} ty_{it} - BidEff_i) \qquad \forall i \in \lambda.$$

34. (Original) The method of Claim 18, wherein said constraints include a constraint to determine pay protection for said airline pilots 58 years old that could have held a position but said position was not awarded, as follows:

$$R_{58i} \geq (N - \sum_{t \in \phi(i)} ty_{jt}) \qquad \forall j \in PP_{58}(i), i \in 58Y.$$

35. (Original) The method of Claim 18, wherein said constraints include four constraints to determine pay protection for said airline pilots 58 years old that hold a position but could have held a better one, as follows:

$$RF_i \geq (N - R_{58i} - \sum_{t \in \phi(i)} ty_{it} + R_i) \qquad \forall i \in \lambda_2,$$

$$M_i \geq (R_i - (N+1)A_{1i}) \qquad \forall i \in \lambda_2,$$

$$M_i \geq (RF_i - (N+1)A_{2i}) \qquad \forall i \in \lambda_2 \text{, and}$$

$$A_{1i} + A_{2i} = 1 \qquad \forall i \in \lambda_2.$$

36. (Original) The method of Claim 18, wherein said user request includes number of

new hires and a request to cluster new hires into groups, and said constraints include following three constraints:

$$\sum_{i \in NH} y_{NHit+L(i)} - KK_t = MM * K_t \qquad \forall t,$$

$$KK_t \leq \text{Residual} * P_t \qquad \forall t, \text{ and}$$

$$\sum_t P_t = 1$$

37. (Original) The method of Claim 18, wherein said user request includes a requirement to cluster new hires into groups, and said optimizer engine determines an optimal number of said new hires, and said constraints include following three constraints:

$$\sum_{i \in NH} y_{NHit+L(i)} - KK_t = MM * K_t \qquad \forall t,$$

$$KK_t \leq MM * P_t \qquad \forall t, \text{ and}$$

$$\sum_t P_t = 1$$

38. (Original) The method of Claim 18, wherein said user request includes a requirement for said optimizer engine to determine balance of captains and first officers in groups for a training class, and Max $\{N_c, N_f\} = N_c$, and a first of following constraints is added to said constraints for each fleet and each bid period to track said groups, and a second of said following constraints is added thereafter to said constraints to enforce minimum percentage:

Σ captains going to training in bid period $t + C_t$
>= Σ first officers going to training in bid period $t + F_t$, and

$$\sum_t C_t \leq N_f(1 - \%balance).$$

39. (Original) The method of Claim 18, wherein said user request includes a requirement for said optimizer engine to determine balance of captains and first officers in groups for a training class, and Max $\{N_c, N_f\} = N_f$, and a first of following constraints is added to said constraints for each fleet and each bid period to track said groups, and a second of said following constraints is added thereafter to said constraints to enforce minimum percentage:

Σ captains going to training in bid period $t + C_t$
$<= \Sigma$ first officers going to training in bid period $t + F_t$, and

$$\sum_t F_t \leq N_c(1 - \%balance).$$

40. (Original) A system for rapidly generating multiple alternative pilot training plans for all pilots in a entire airline, which comprises:

a user interface receiving user requests and input data from a user, and providing status messages for informing said user;

an optimizer system in electrical communication with said user interface for generating said status messages, and in response to receiving said user requests and said input data, rapidly generating said multiple alternative pilot training plans by creating variables and constraints, creating a mixed integer programming model from said variables and said constraints, and thereafter solving said mixed integer programming model; and

a database in electrical communication with said optimizer system, and receiving said user requests, said input data, said status messages, and said multiple alternative pilot training plans from said optimizer system for storage and access by said user.

41. (Original) An optimizer engine for rapid generation of pilot training plans which receives pilot data and user requests from a database system, and which comprises:

means for operating upon said pilot data and user requests to build parameter lists, variable lists, and constraint lists;

means for building a mixed integer programming model from said parameter lists, said variable lists, and said constraint lists;

means for solving said mixed integer programming model to generate variable value solutions; and

means for generating multiple alternative pilot training plans from said variable value solutions.

42. (Original) The optimizer engine of Claim 41, wherein parameters in said parameter lists are varied to determine those of said variable value solutions which are revenue enhancing.

43. (Original) The optimizer engine of Claim 41, wherein said optimizer engine accommodates seamless integration into data processing environments.

44. (Original) The optimizer engine of Claim 41, wherein said pilot training plans maximize pilot availability, optimize use of training resources, and track costs and events occurring in said pilot training plans.

45. (Original) The optimizer engine of Claim 41, wherein said optimizer engine generates said alternative pilot training plans in less than one hour after receipt of said pilot data and user requests.

46. (Original) The optimizer engine of Claim 41, wherein said means for solving generates and solves an LP relaxation of said mixed integer programming model to determine feasibility before solving said mixed integer programming model.

47. (Original) The optimizer engine of Claim 46, wherein said means for solving calculates costs for said LP relaxation and generates therefrom modified objective function cost factors based upon block hour and dollar costs of said mixed integer programming model.

48. (Original) The optimizer engine of Claim 42, wherein said parameters are comprised of sub-base openings, sub-base closings, vacation cancellations, levels of importance, costs, capacity, excesses, shortages, and training resource availability.

49. (Original) The optimizer engine of Claim 41, wherein said means for solving assigns each of said multiple alternative pilot training plans a comparative value to assist in selecting an optimum pilot training plan.

50. (Original) The optimizer engine of Claim 41, wherein said multiple alternative pilot training plans include pay protection, instructor and pilot staffing, schedule for hiring new hires, optimum number of new hires per position, training assignments, advancements, and releases.

51. (Original) The optimizer engine of Claim 41, wherein said means for solving optimizes said variable value solutions by minimizing an objective function of said mixed integer programming model to

have a minimum value within a region defined by constraints in said constraint lists.

52. (Original) The optimizer engine of Claim 48, wherein said levels of importance are generated for block hour excesses, block hour shortages, pay protection costs, new hire costs, no award costs, and furlough costs occurring in said mixed integer programming model.